## **CLAIMS**

[1] A light-collecting device which collects incident light, comprising:

a substrate into which the incident light is incident; and above said substrate, a plurality of light-transmitting films formed in a region into which the incident light is incident,

wherein said light-transmitting film forms a zone in which a width of each zone is equal to or shorter than a wavelength of the incident light, and

the plurality of said light-transmitting films form an effective refractive index distribution.

- [2] The light-collecting device according to Claim 1, wherein in the plurality of said light-transmitting films, each light-transmitting film has a constant line width.
- [3] The light-collecting device according to one of Claim 1 and Claim 2,

wherein in one of areas of said light-transmitting films divided by a length equal to or shorter than the wavelength of the incident light, a sum of the line widths of the light-transmitting films is smaller than a sum of the line widths in another one of the areas that is closer to a zone center.

- 25 [4] The light-collecting device according to Claim 3, wherein the zone model is concentric circles.
  - [5] The light-collecting device according to Claim 3 wherein

$$\Delta n(r) = \Delta n_{\text{max}} \left[ 1 + m - n_1 r^2 / (2\lambda f) \right]$$

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is approximately satisfied, where  $\lambda$  is the wavelength of the incident light, f is a focal length,  $n_0$  is a refractive index of a

medium on a light incoming side,  $n_1$  is a refractive index of a medium on a light outgoing side, m is a non-negative integer, and a maximum value of a refractive index of said light-transmitting film is  $n_0 + \Delta n_{\max}$ , when a difference from the  $n_0$  is  $\Delta n(r)$ .

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[6] The light-collecting device according to Claim 3, wherein

$$W = a(1 + m - n_1 r^2 / (2rf))$$

is satisfied, where  $\lambda$  is the wavelength of the incident light, f is a focal length, a is a width of the divided area,  $n_1$  is a refractive index of a medium on a light outgoing side, m is a non-negative integer, and  $r_m$  is a Fresnel zone boundary, that is a natural number which satisfies  $r_m^2 = 2m\lambda f/n_1$ , taking that a sum W of the line widths of said light-transmitting films in one of the divided areas having an inner radius r where r is larger than  $r_m$  and smaller than  $r_{m+1}$ .

[7] The light-collecting device according to Claim 1, wherein heights of said light-transmitting films are constant in a direction normal to said light-transmitting films.

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[8] The light-collecting device according to Claim 1, wherein a shape of cross sections of said light-transmitting films in a direction normal to said light-transmitting films is rectangular.

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- [9] The light-collecting device according to Claim 1, wherein each of said light-transmitting films includes one of TiO<sub>2</sub>, ZrO<sub>2</sub>, Nb<sub>2</sub>O<sub>5</sub>, Ta<sub>2</sub>O<sub>5</sub>, Si<sub>3</sub>N<sub>4</sub> and Si<sub>2</sub>N<sub>3</sub>.
- 30 [10] The light-collecting device according to Claim 1, wherein each of said light-transmitting films includes one of SiO<sub>2</sub> doped with B or P, that is Boro-Phospho Silicated Glass, and

Teraethoxy Silane.

- [11] The light-collecting device according to Claim 1, wherein each of said light-transmitting films includes one of benzocyclobutene, polymethymethacrylate, polyamide and polyimide.
- [12] A solid-state imaging apparatus comprising unit pixels that are arranged in a two-dimensional array, each unit pixel including a respective light-collecting device,

wherein said light-collecting devices comprises:

a substrate into which the incident light is incident; and above said substrate, a plurality of light-transmitting films formed in a region into which the incident light is incident,

wherein said light-transmitting film forms a zone in which each zone is equal to or shorter than a wavelength of the incident light, and

the plurality of said light-transmitting films form an effective refractive index distribution.

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- [13] The solid-state imaging apparatus according to Claim 12, wherein line widths of said light-transmitting films are different between said light-collecting devices of said unit pixels located close to a zone center and said light-collecting devices of said unit pixels located near the zone periphery.
- [14] The solid-state imaging apparatus according to Claim 12, comprising at least:
- a first unit pixel for first color light out of the incident light; 30 and

a second unit pixel for second color light which has a typical wavelength that is different from a typical wavelength of the first

color light;

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wherein said first unit pixel includes a first light-collecting device, and

said second unit pixel includes a second light-collecting device in which a focal length of the second color light is equal to a focal length of the first color light in said first light-collecting device.

- [15] The solid-state imaging apparatus according to Claim 12, wherein sums of the line widths of said light-transmitting films in each of the divided areas are different between a light-collecting device of said unit pixel located in a center of a plane on which said unit pixel is formed and a light-collecting device of said unit pixel located in the periphery of the plane.
- 15 [16] The solid-state imaging apparatus according to Claim 12, wherein a plane on which said pixels are formed is divided by concentric areas from a center of the plane to the periphery,

focal lengths of said light-collecting devices of said unit pixels belonging to a same area are equal, and

focal lengths of said light-collecting devices of said unit pixels belonging to areas other than the same area are different.

- [17] The solid-state imaging apparatus according to Claim 12, wherein each unit pixel further includes:
- a wiring layer having an aperture above a light-receiving device, on a light-outgoing side plane of said light-collecting device, and

a focal point of light collected by said light-collecting device matches a position of the aperture of said wiring layer.

[18] The solid-state imaging apparatus according to Claim 17, wherein in said unit pixels located in a center of a plane on

which said unit pixels are formed, a central axis of each of said light-receiving devices is placed to match a central axis of each of said light-collecting devices, and

in said unit pixels located in the periphery of the center of the plane, a central axis of each of said light-receiving devices and a central axis of each of said light-collecting devices are placed toward the center of the plane.